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Application No. S2004/0026

Date of Filing 15 January 2004

Applicant ELEMENT SIX LIMITED, a company registered according to the laws of Ireland of Shannon Airport, Shannon, County Clare, Ireland.

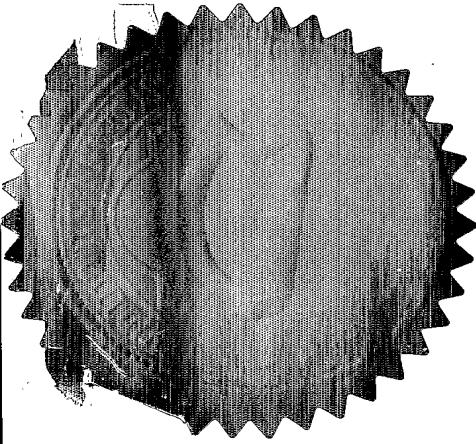
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FORM NO. 1

REQUEST FOR THE GRANT OF A PATENT

PATENTS ACT, 1992

The Applicant(s) named herein hereby request(s)
 the grant of a patent under Part II of the Act

the grant of a short-term patent under Part III of the Act on the basis of the information furnished hereunder.

1. Applicant(s)

me Element Six Limited

Address Shannon Airport, Shannon, County Clare, Ireland.

Description/Nationality A company registered according to the laws of Ireland.

2. Title of Invention

Coated Abrasives.

Declaration of Priority on basis of previously filed application(s) for same invention (Sections 25 & 26)

Previous filing date Country in or for which filed Filing No.

4. Identification of Inventor(s)

Name(s) of person(s) believed
by Applicant(s) to be the inventor(s)

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Ireland.

5. Statement of right to be granted a patent (Section 17(2)(b))

The Applicant acquired the rights in the invention by virtue of the inventors' Contracts of Employment.

6. Items accompanying this Request - tick as appropriate

(i) Prescribed filing fee (€ 60)

(ii) Specification containing a description and claims
 Specification containing a description only
 Drawings referred to in description or claims

(iii) An abstract

(iv) Copy of previous application(s) whose priority is claimed

(v) Translation of previous application whose priority is claimed

(vi) Authorisation of Agent (this may be given at 8 below if this Request is signed by the Applicant(s))

7. Divisional Application(s)

The following information is applicable to the present application which is made under Section 24 -

Earlier Application No:

Filing Date:

Agent

The following is authorised to act as agent in all proceedings connected with the obtaining of a patent to which this request relates and in relation to any patent granted -

Name Address

ANNE RYAN & CO. 60 Northumberland Road,
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9. Address for Service (if different from that at 8)

ANNE RYAN & CO., Authorised Patent Agents.

Signed

Name(s): by: Caroline O'Leary
Capacity (if applicant is a body corporate):

Date

January 15, 2004

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- 1 -

BACKGROUND OF THE INVENTION

This invention relates to coated abrasives, a process for their production, and to coated abrasives for use in abrasive-containing tools.

Abrasive particles such as diamond and cubic boron nitride are commonly used in cutting, grinding, drilling, sawing and polishing applications. In such applications, abrasive particles are mixed with metal powder mixes, then sintered at high temperatures to form bonded cutting elements. Typical bond matrices contain iron, cobalt, copper, nickel and/or alloys thereof.

Common problems in applications are retention of particles in the bond matrix, and resistance against oxidative attack during the sintering process and the subsequent application.

These problems are commonly addressed by coating the abrasive particles with metals or alloys which bond chemically to the particle, and alloy to the bond matrix. Typically, chemical vapour deposition (CVD) or physical vapour deposition (PVD sputter coating) techniques are used. Titanium carbide is an example of a material that has been proposed as a coating for abrasive particles, because of its good adhesion to diamond. Chromium carbide is a similar coating material that can be used.

A problem with the use of titanium carbide coatings where the bond matrix contains bronze or Cu is that these materials tend to react with the titanium carbide, such that it may be reacted away. The diamond particles are then susceptible to graphitisation of the diamond particle surfaces, where the bond matrix consists of metals that are typically used as solvent/catalysts for diamond synthesis. Examples of such metals are Fe, Co and Ni. In the molten state, these metals are capable of dissolving diamond, which precipitates on cooling to form graphite. This process of graphitisation of the diamond surface not only weakens the particles but may also result in poorer retention of the particles in the bond.

During manufacture of cutting tools, for example during sintering of saw segments containing diamond particles, oxygen may be present as surface oxides, dissolved oxygen in the metal powders that form the bond matrix, or in gaseous form in the atmosphere or as a consequence of application of the titanium carbide coating itself. At the sintering temperatures this oxygen is liable to attack the surface of the diamond particles, which weakens the particles.

SUMMARY OF THE INVENTION

A coated super-hard abrasive comprising a core of super-hard abrasive material, an inner layer of a metal carbide, nitride, boride or carbonitride chemically bonded to an outer surface of the super-hard abrasive material and an outer layer of metal carbonitride, in particular titanium carbonitride.

The outer layer is preferably applied by physical vapour deposition.

The ultra-hard abrasive material is typically diamond or cBN based, and may include diamond or cBN grit, PCD substrates, thermally stable PCD (TSPCD) substrates, P_cBN substrates, CVD diamond film, single crystal diamond substrates.

The inner layer is formed from an element capable of forming (singly or in combination) carbides, nitrides or borides to the surface(s) of the abrasive material when applied as an inner layer using a hot coating process. Typically these elements come from groups IVa, Va, VIIa, IIIb and IVb of the periodic table. The inner layer is preferably a titanium or chromium carbide coating in the case of a diamond abrasive core, or a titanium or chromium nitride, boride or boronitride coating in the case of a cBN abrasive core, although other metals such as vanadium, molybdenum, tantalum, indium, zirconium, niobium, tungsten, aluminium, boron or silicon, for example, could also be used.

DESCRIPTION OF PREFERRED EMBODIMENTS

Whilst the invention extends to various forms of coated abrasive material, it will in the most part be described with reference to the coating of diamond grit for convenience.

Ti in the form of titanium carbide or titanium nitrides and borides have been shown to be useful coating materials for diamond and cBN substrates,

respectively. They are particularly useful because of their ability to bind chemically to the substrate and to protect the substrate. However, as has been mentioned previously, they are not suitable in some applications, particularly where they are sintered in aggressive sintering conditions in the presence of bronze or copper, and where the bond matrix contains ferrous metals, for example, or in the presence of oxygen.

It has been found that the advantages of titanium coatings can be extended to other applications utilising diamond grits where an outer coating of a metal carbonitride, in particular titanium carbonitride, is applied over the titanium coating layer. This is particularly the case where diamond grit is used in a metal bond matrix containing ferrous metals to form an abrasive tool component upon sintering. It forms a barrier to the diffusion of Co, Fe and Ni from a metal bond matrix thereof, allowing it to be used in low Cu in Fe, Co and Cu hot pressing processes and in pure iron bonds even where sintering conditions require long sintering times and high temperatures. It is also useful where the titanium carbide coating, in the case of diamond particles, would be reacted away by a constituent of the metallic material, for example bronze and copper brazing of the material to another metallic or ceramic material, or sintering or infiltrating a powder to form an infiltrated powder material.

It is especially useful in the making of diamond impregnated tools such as segments for saw blades, drills, beads for diamond wires especially where high amounts of bronze or copper limit the usefulness of titanium carbide coatings, the making of brazed diamond layer tools such as brazed diamond wire beads, the making of diamond containing metal matrix composites, brazing of diamond materials such as affixing TSPCD, PCD and diamond drillstones to a drill body, affixing CVD, monocrystal, TSPCD and PCD to a saw blade, tool post, drill body and the like.

Additionally, the coated diamond impregnated tools yield improved performance such as longer tool life and higher productivity. Coated diamond particles of the invention for brazing applications allow the use of

simple brazes that work in air as opposed to active brazes containing Ti which require the exclusion of oxygen.

The coated abrasive particles are preferably formed using a hot coating process for applying the inner layer and a PVD process for applying the outer layer.

The diamond grit particles are those used conventionally in the manufacturing of metal bonded tools. They are generally uniformly sized, typically 0.1 to 10 mm. Examples of such diamond grit particles include Micron grit 0.1 to 60 micron, wheel grit 40 micron to 200 micron, saw grit 180 micron to 2 millimeter, mono crystal 1 millimeter to 10 millimeter, CVD inserts of a few square millimeter to discs up to 200 millimeter diameter, PCD inserts of a few square millimeter to discs 104 millimeter diameter, cBN grit in micron range 0.1 to 60 micron, in wheel grit range 40 micron to 200 micron, PCBN inserts of a few mm to discs up to 104 mm diameter.

The diamond particles are first coated in a hot coating process to provide an inner layer, which may be a metal layer or a metal carbide, nitride or carbonitride layer. In the case of cBN, such inner coating would typically be a metal nitride or boride or boronitride layer. In this hot coating process, the metal-based coat is applied to the diamond substrate under suitable hot conditions for such bonding to take place. Typical hot coating technologies that can be used include processes involving deposition from a metal halide gas phase, CVD processes, or thermodiffusion vacuum coating or metal vapour deposition processes, for example. Deposition from a metal halide gas phase and CVD processes are preferred, with processes involving deposition from a metal halide gas phase being particularly preferred.

In processes involving deposition from a metal halide gas phase, the particles to be coated are exposed to a metal-halide containing the metal to be coated (e.g. Ti) in an appropriate gaseous environment (e.g. non-oxidising environments containing one or more of the following: inert gas,

hydrogen, hydrocarbon, reduced pressure). The metal halide may be generated from a metal as part of the process.

The mixture is subjected to a heat cycle during which the metal-halide transports the Ti to the surfaces of the particles where it is released and is chemically bonded to the particles.

The outer metal carbonitride layer is deposited using a CVD process or a cold coating technique such as PVD, which is preferred. This is a low temperature process in that insufficient heat is generated to cause significant carbide chemical bonding to the substrate. Hence, if used alone, it would result in poor adhesion to the diamond particles. An example of a PVD process for applying the outer coating is reactive sputter coating in which a reactive gas such as a hydrocarbon gas and/or nitrogen is admitted during the coating. The gas reacts with the metal vapour formed by the sputtering process resulting in the deposition of carbonitrides. In this method, the ratio of Ti:(C,N) and C:N can be optimized to further enhance the properties of the outer layer.

The outer layer(s) is/are typically comprised (whether singly or in combination) of carbides, nitrides, borides, oxides and silicides of metals from groups IVa, Va, VIa, such as titanium and chromium, from groups IIIb and IVb, such as aluminium, and elements such as boron and silicon, but is/are preferably comprised of titanium carbide, titanium carbonitride, titanium nitride, titanium boride or titanium boronitride.

ANNE RYAN & CO.
AGENTS FOR THE APPLICANTS